30 May 2017
Project Number: 170253

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Re: Task 1 Data Used to Establish Phosphorus Targets

DATA USED TO ESTABLISH BINATIONAL PHOSPHORUS REDUCTION TARGETS

The *Ohio Lake Erie Phosphorus Task Force II Final Report* (2013) originally proposed the 40% reduction target for total and dissolved reactive phosphorus loading to Lake Erie. The target was based on phosphorus loading data from the Maumee River and its correlation to the size of algal blooms in Lake Erie each year.

The official data regarding phosphorus loading to Lake Erie is best presented and most easily accessible in Appendices S1 and S2 of *Total and soluble reactive phosphorus loadings to Lake Erie: A detailed accounting by year, basin, country, and tributary* (Maccoux et al., 2016), where it is available for download in excel format.

Total phosphorus loading data to Lake Erie is available beginning in 1967. Beginning in 1974 the data is further subdivided into nonpoint source and point source contribution, and as of 2003 the data is subdivided by tributary. This means that nonpoint source phosphorus loading data for the Thames watershed is available for 2003-2013. Additionally from 2009 onwards there is data available for dissolved reactive phosphorus (DRP) loads from each tributary and broken down into nonpoint and point source contributions.

The data was originally collected by Canadian and U.S. government monitoring stations as well as Heidelberg University of Ohio and is available in online databases. Table 1 summarizes the original source and location of this data.

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Table 1: (Maccoux et al., 2016)

Listing of Data Sources			
Data type(s)	Source agency	Division	Link (email contact)
Tributary discharge	Environment and Climate Change Canada	Water Survey of Canada-HYDAT	http://wateroffice.ec.gc.ca/search/search_e.html?sType=h2oArc
	U.S. Geological Survey	Water Resources Division-NWIS	http://waterdata.usgs.gov/nwis/nwis
Tributary water quality	Environment and Climate Change Canada	Water Quality Monitoring and Surveillance Division	http://open.canada.ca/en/
			(wqms-info@canada.ca)
	Heidelberg University	National Center for Water Quality Research	https://www.heidelberg.edu/academics/research-and-centers/national-center-water-quality-research/tributary-data-download
	Michigan Department of Environmental Quality	Water Resources Division	http://www.mcgi.state.mi.us/miswims/
			(DEQ-WEBMASTER@michigan.gov)
			(DNR-MiSWIMS@michigan.gov)
	Ohio Environmental Protection Agency	Division of Surface Water	http://www.epa.state.oh.us/dsw/SurfaceWater.aspx
	Ontario Ministry of Environment and Energy	PWQMN	https://www.ontario.ca/data/provincial-stream-water-quality-monitoring-network
	U.S. Environmental Protection Agency	STORET	http://www3.epa.gov/storet/dbtop.html
	U.S. Geological Survey	Water Resources Division-NWIS	http://waterdata.usgs.gov/nwis/nwis
Point source	Ontario Ministry of Environment and Energy	MISA	https://www.ontario.ca/data/industrial-wastewater-discharges
	U.S. Environmental Protection Agency	Water Division-PCS/ICIS	http://www3.epa.gov/enviro/facts/pcs-icis/search.html
Atmospheric deposition	Environment and Climate Change Canada	Water Quality Monitoring and Surveillance Division	(wqms-info@canada.ca)

ESTIMATED AGRICULTURAL CONTRIBUTION TO PHOSPHORUS LOADS

As measuring all points of agricultural runoff from farm fields in the Thames watershed to determine agriculture's contribution to phosphorus loading is logistically and financially prohibitive, it may be useful to apply an average phosphorus runoff load value to all agricultural lands to estimate annual phosphorus loss from farm lands. In an attempt to establish the percentage of agricultural contribution to phosphorus loading in the Thames watershed, farm field runoff data from (Van Esbroeck et al., 2016) was combined with land use data from (Nurnberg & LaZerte, 2015).

The (Van Esbroeck et al., 2016) study quantified a kilogram per hectare per year (kg/ha/yr) value for the amount of phosphorus discharged from 2 working farms in southwestern Ontario. Data included discharge from both tile drainage and surface runoff, for both total phosphorus and dissolved reactive phosphorus. For the purpose of this estimate these farm sites are considered representative of farm land in southwestern Ontario and therefore the kg/ha/yr of phosphorus value is considered reasonable to apply to all agricultural land in the Thames watershed. Full descriptions of site conditions are included in Appendix A.

Using a value of 80% agricultural land use in the Thames watershed as stated in (Nurnberg & LaZerte, 2015), and the kg/ha/yr of phosphorus values reported in (Van Esbroeck et al., 2016) a phosphorus load due to agriculture was calculated. The calculated values were then compared with the known values for nonpoint source phosphorus loading in the Thames River (total annual Thames River phosphorus export load minus monitored point source export loads) and a contribution from agriculture was established. It was determined that agriculture possibly contributes 18-51% of the dissolved reactive phosphorus load, and 66-74% of the total phosphorus load from nonpoint sources in the Thames (Table 2).

It is worth emphasizing that this estimate is based on one study, and that several assumptions have been made to establish these values. These included: assuming the majority of farms in the Thames have similar tile drainage and surface runoff to the farms in the study, assuming a similar abundance of preferential flow paths (cracks or biopores) and similar soil type, assuming similar best management practices such as reduced tillage, and assuming a similar soil test P of 12-15ppm for the majority of farms in the Thames.

It should be noted that the majority of farms in Ontario are known to have soil test P values significantly higher than 15ppm. According to data collected in 2015 by the International Plant Nutrition Institute, 83% of soil samples in Ontario tested higher than 15ppm and 36% tested higher than 50ppm (Bruulsema, 2016). While a correlation has been established between soil test P and DRP runoff concentration, a correlation was not found between soil test P and DRP load (Pote et al., 1996) as total load is runoff water volume dependent. Nevertheless the authors maintained that there could be a correlation between soil test P and DRP load, and it is therefore possible that agriculture may be contributing more to nonpoint source phosphorus loading than the estimates presented here

Sincerely yours,
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Encl.

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Table 2: Agricultural Contribution to Nonpoint Phosphorus Load in Thames Watershed

Monitoring Site	Tile	Surface	Combined	Agri. Tile Load†	Agri. Surface Load†	Agri. Combined Load†	NP P Load*	% Agri.
	kg P/ha	kg P/ha	kg P/ha	MTA	MTA	MTA	MTA	
DRP Load								
ILD	0.023	0.011	0.034	10	5	16	86	18
LON	0.018	0.078	0.096	8	36	44	86	51
TP Load								
ILD	0.255	0.077	0.332	116	35	152	230	66
LON	0.185	0.186	0.371	84	85	169	230	74

Notes:

ILD	Monitored agricultural field in SW Ontario from (Van Esbroeck et al. 2016)
LON	Monitored agricultural field in SW Ontario from (Van Esbroeck et al. 2016)
Tile	Phosphorus load (kg/ha) from tile drainage
Surface	Phosphorus load (kg/ha) from surface runoff
Combined	Phosphorus load (kg/ha) from tile drainage and surface runoff
Agri. Tile Load	Agricultural contribution from tile drainage to phosphorus loading in Thames watershed **(calculated)**
Agri. Surface Load	Agricultural contribution from surface runoff to phosphorus loading in Thames watershed **(calculated)**
Agri. Combined Load	Agricultural contribution from surface and tile drainage to phosphorus loading in Thames watershed **(calculated)**
NP P Load	Phosphorus load to Thames Watershed from non-point sources (Maccoux et al. 2016)
% Agri.	Percentage of non-point source phosphorus load contributed by agriculture
*	Nonpoint source load averaged between years 2012 and 2013
†	Calculations assumed all agricultural land in watershed had similar tile drainage, soil conditions, and farming practices to the monitored site

Area of Thames Watershed = 5706 km^2

% of Thames Land Use belonging to Agriculture = 80%

ILD: UTM 17T 472,219mE, 4,767,583mN
Hummocky topography with imperfectly drained Thorndale Silt Loam and Embro Silt Loam soils. Soil test P in top 15cm is 12-15mg/kg. Corn-soy-winter wheat rotation. Reduced tillage strategy (rotational, non-aggressive disturbance). Working farm. (Van Esbroeck et al. 2016)

LON: UTM 17T 466,689mE, 4,832,203mN
Gently undulating terrain with imperfectly drained Perth Clay Loam soil. Soil test P in top 15cm is 12-15mg/kg. Corn-soy-winter wheat rotation. Reduced tillage strategy (rotational, non-aggressive disturbance). Working farm. (Van Esbroeck et al. 2016)

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APPENDIX A

Site ILD: The site is located at UTM 17T 472,219mE, 4,767,583mN and is characterized by hummocky topography with imperfectly drained Thorndale Silt Loam and Embro Silt Loam soils. The soil test P in the top 15cm ranged from 12-15ppm. The farm has a corn-soy-winter wheat rotation and uses a reduced tillage strategy (rotational, non-aggressive disturbance). It is an active working farm.

Site LON: The site is located at UTM 17T 466,689mE, 4,832,203mN and is characterized by gently undulating terrain with imperfectly drained Perth Clay Loam soil. The soil test P was very similar to site ILD ranging from 12-15ppm in the top 15cm. This site also had a corn-soy-winter wheat crop rotation and used a reduced tillage strategy (rotational, non-aggressive disturbance). It is also an active working farm.